INTELLIGENT PUMPING SYSTEMS:

OPTIMIZING PUMP LIFE CYCLE PERFORMANCE

Pumping System Performance

Can Make or Break Your Bottom Line!

- **Energy & Maintenance Savings:**
  - Balancing supply with load improves efficiency and reliability
  - Increase process uptime via improved pump performance
  - Variable speed adjust energy usage according to need
- **Asset Management:**
  - Predictive maintenance via pump intelligence
  - Reduce parts inventory requirements
- **Improved Process Control:**
  - Variability reduction saves material and energy
  - Better product quality & throughput

"Motor and Valve Performance is the Weak Link in Many Control Loops"
Source: Automation Research Corporation
Strategies to Drive Manufacturing Efficiency on the Production Floor

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Typical Assessment Results

Integrated Pulp & Paper Mill

- Eight (8) Pumping Systems
  - Horsepower Reduction - 950 HP
    - 3125 Installed - 2175 Required
  - Total Installed Cost - $530
  - Total Savings (3 Yr.) - $1,012
  - Mean Payback Period - 13 months
  - Mean Net Present Value - $38K
  - All Projects NPV - $358K

- The 15 pumps studies represent less than 2% of the plant pump population

- Approximately 20% of the pumps are candidates for optimization

Intelligent Pumping System

Just What Is It?

PumpSmart

Unique Capabilities

- Automatically Adjusts to Process Changes
- Automatically Adjust to Pump System Changes
- Fault Tolerance, e.g., can slow down to protect pump
- Understands When to Resume Safe Operation

PumpSmart: Major Components

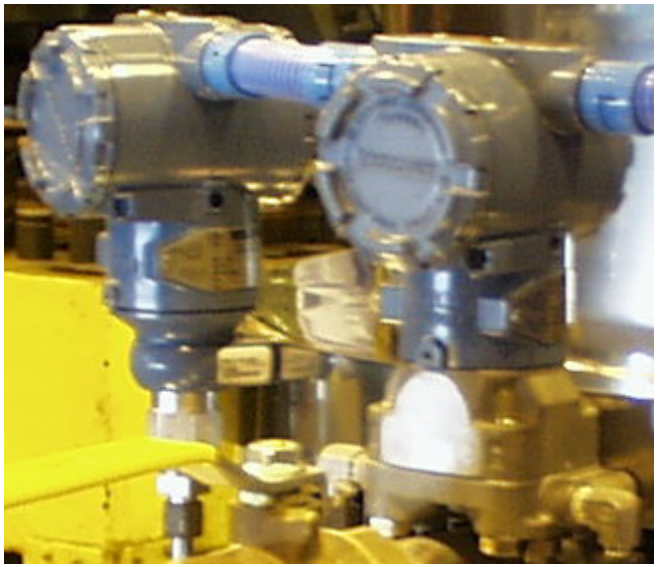
- **Pump and Motor**
  - Any Manufacturer
- **Variable Speed Drive**
  - ABB ACS 600 Drive
    - PS 200
    - PS 300
  - Instrumentation
  - Any Manufacturer
- **Microprocessor**
  - Standard VFD Motherboard
- **Special Software**
  - Goulds' Algorithms
  - Pump Domain Knowledge

Instrumentation

(ONE or More Parameters Depending on Application)

- **Discharge Pressure**
  - Control plus Fault Protection
- **Discharge Flow**
  - Control plus Fault Protection
- **Other Control Parameters**
  - Level, Temperature, ect.

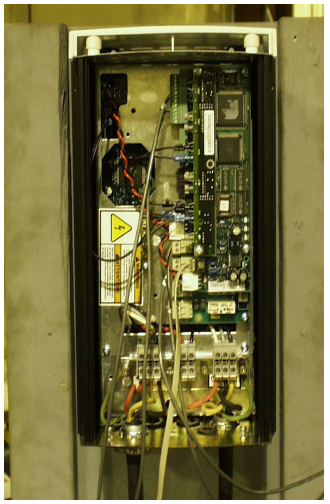
- **Suction Pressure**
  - Condition Monitoring, as needed
- **Suction Temperature**
  - Condition Monitoring, as needed



Download Data to Microprocessor

User friendly configuration onsite or factory

- Pump Hydraulic Characteristics
- Fluid Characteristics
- Control Parameters
- Alarm Settings
- Multi-pump Sequencing
  - Up to Four Parallel Pumps
- Vibration Monitoring
  - Bearings and Casing



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PumpSmart Protects Against:

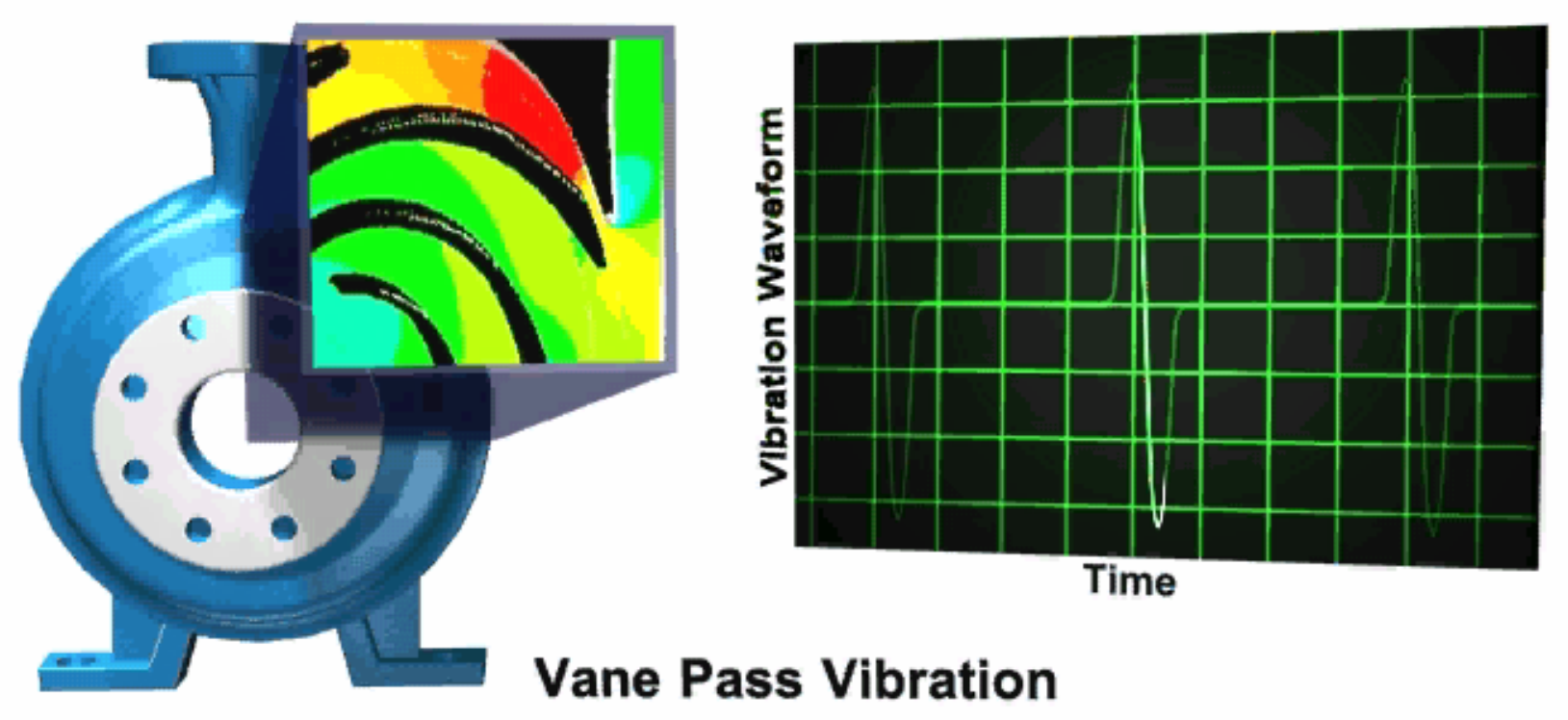
- Closed Suction Valve
- Closed Discharge Valve
- Cavitation Conditions
- Minimum Flow
- Dry Running
- Other Safeguards:
  - Over - pressure, temperature, current, speed

PumpSmart Improve Reliability (MTBF)

- **Operating Range**
  - Flow or Head
  - Runs near BEP
- **Operating Speed**
  - Lower RPM
- **Impeller Diameter**
  - 25% of Trim Range
  - Reduces Vibration

Example: Lower Maintenance Cost Impeller

Cutwater Diameter Gap - 25% Wider



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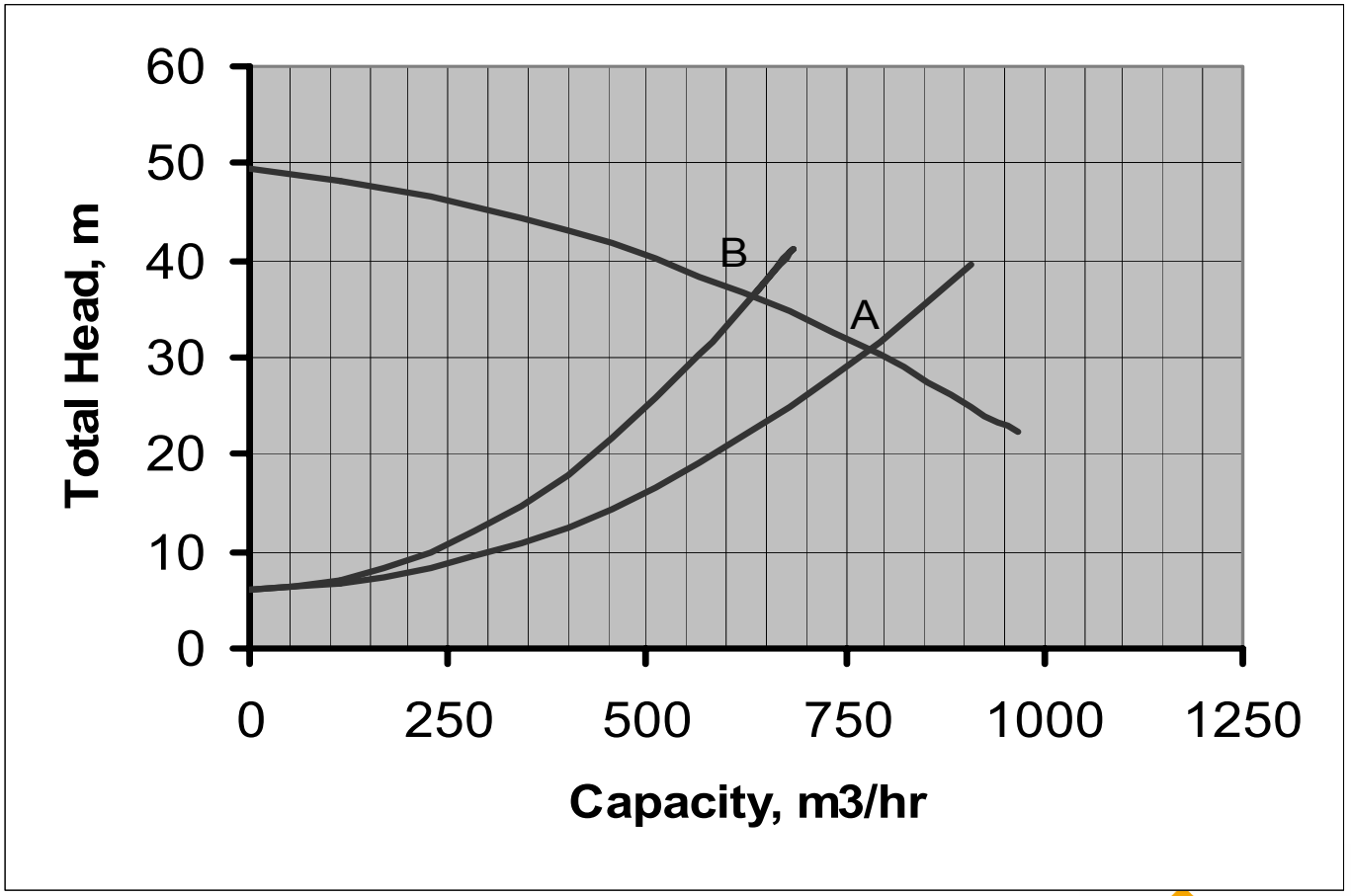
Pump Performance Curve

Fixed Speed: *Limits HQ Flexibility*



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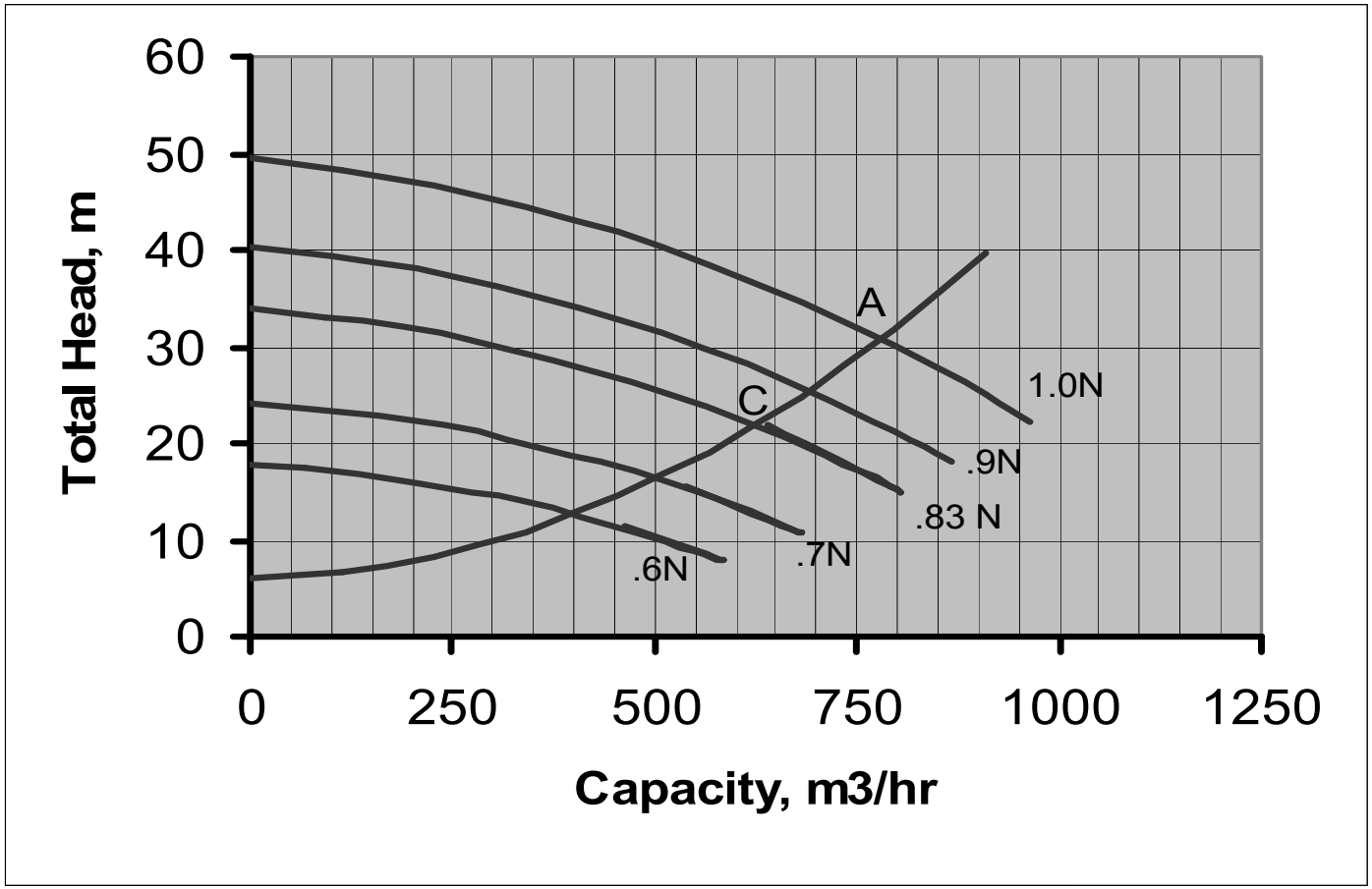
Pump Performance Curve

Variable Speed: *Maximizes HQ Flexibility*



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PumpSmart vs. Control Valve

% of BEP across Flow Range

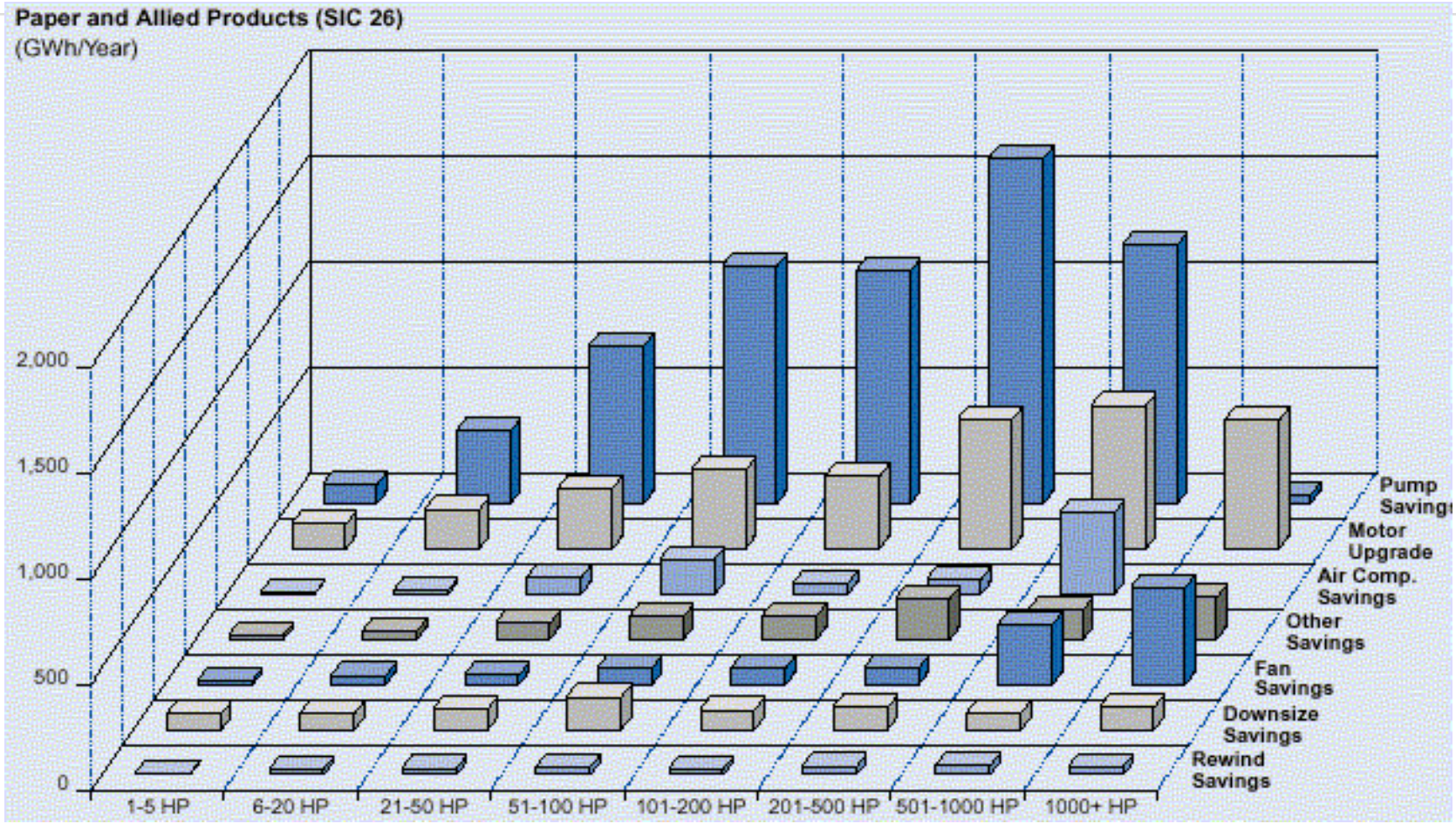
Flow Rate (gpm)	Duty Cycle % of Time	Control Valve Pressure Drop (psid)	Pump % of BEP	VFD Speed RPM	Pump % of BEP
400	10	1	86%	1750	87%
280	30	17	31%	1225	86%
120	50	30	26%	508	90%
80	10	31	17%	315	95%

Pumping Systems Are Energy Intensive

Industry Type	Pump Energy (Percentage of Total Motor Energy Use)
Petroleum	59%
Forest Products	31%
Chemicals	26%
Food Processing	19%
Primary Metals	9%

A 75 hp pump uses about $20,000 in electricity annually

P&P Motor Energy Usage



Pumps offer the largest potential for process energy savings

Source: DOE-OIT

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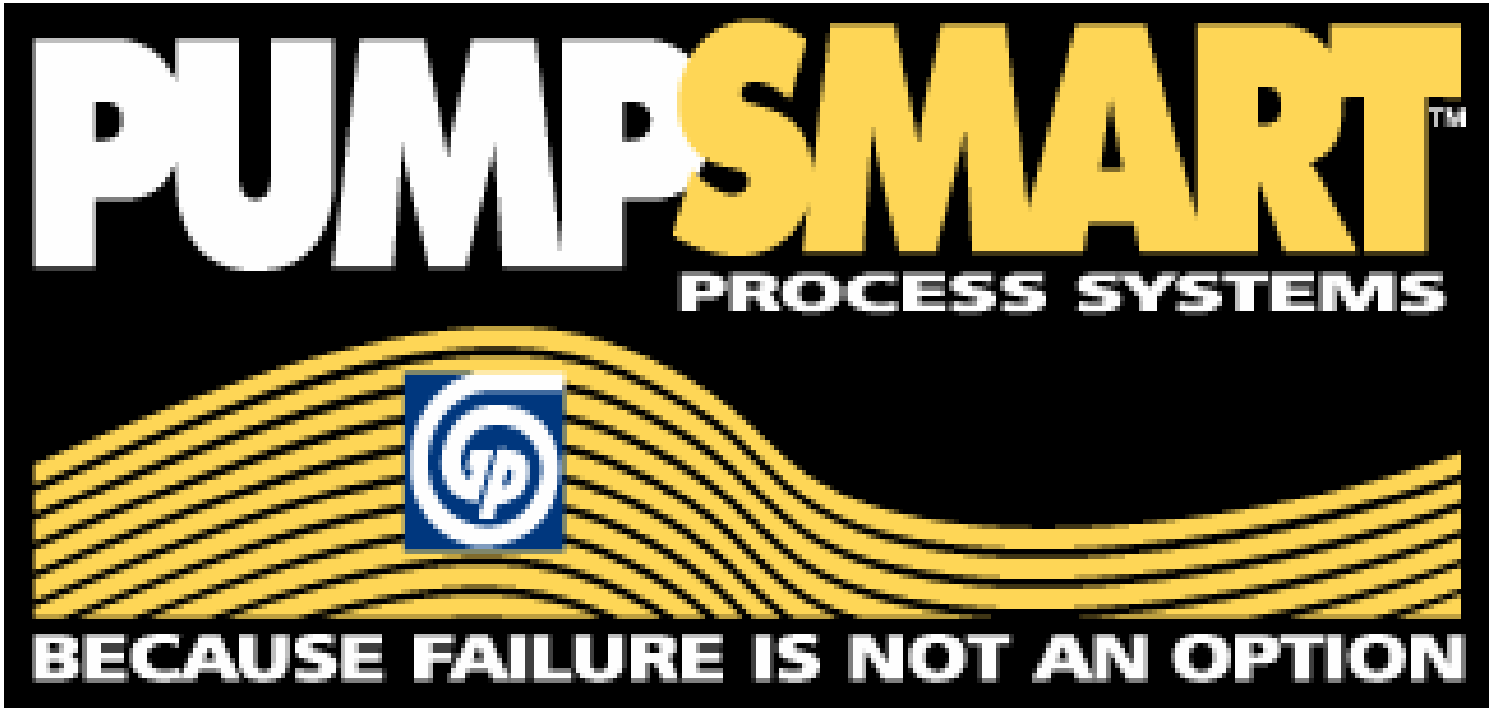

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PumpSmart Value Proposition

- Lower Life Cycle Cost
  - Initial Cost
  - Installation Cost
  - Operational Cost
  - Maintenance Cost
- Improved Process Control
  - Solid- State Drives vs. Pneumatic Valve Improves Performance
  - Utilizes PID algorithm in VFD or in the DCS
  - Unique Algorithm Controller (adaptive)
- Asset Management
  - Operational Data (80:1 data explosion)
  - Condition Monitoring (e.g., TDH actual, NPSH actual)
  - Links to DCS, Asset Management Software, and CMMS

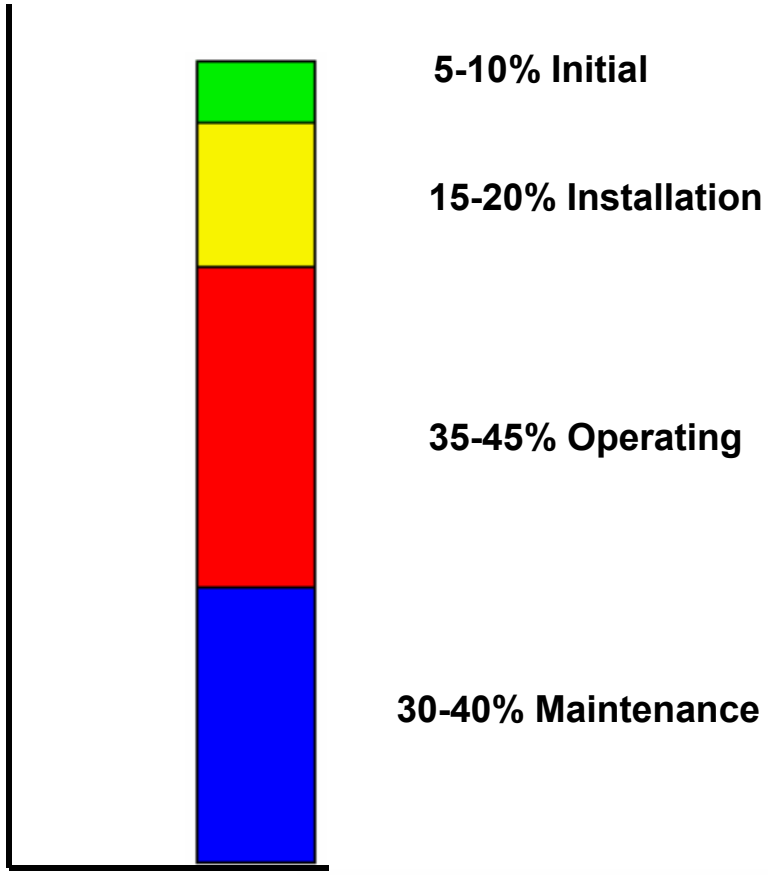
PumpSmart: A Tool to Lower Life Cycle Cost

"Optimizing Pump Systems"

Pump Life Cycle Cost

(Total Potential Reduction of 30 to 70%)

- **Initial Cost**
  - less components
- **Installation Cost**
  - on new projects
- **Operating Cost**
  - energy, process
- **Maintenance Cost**
  - MTBF, repairs



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Energy to Burn
Maintenance too Frequent

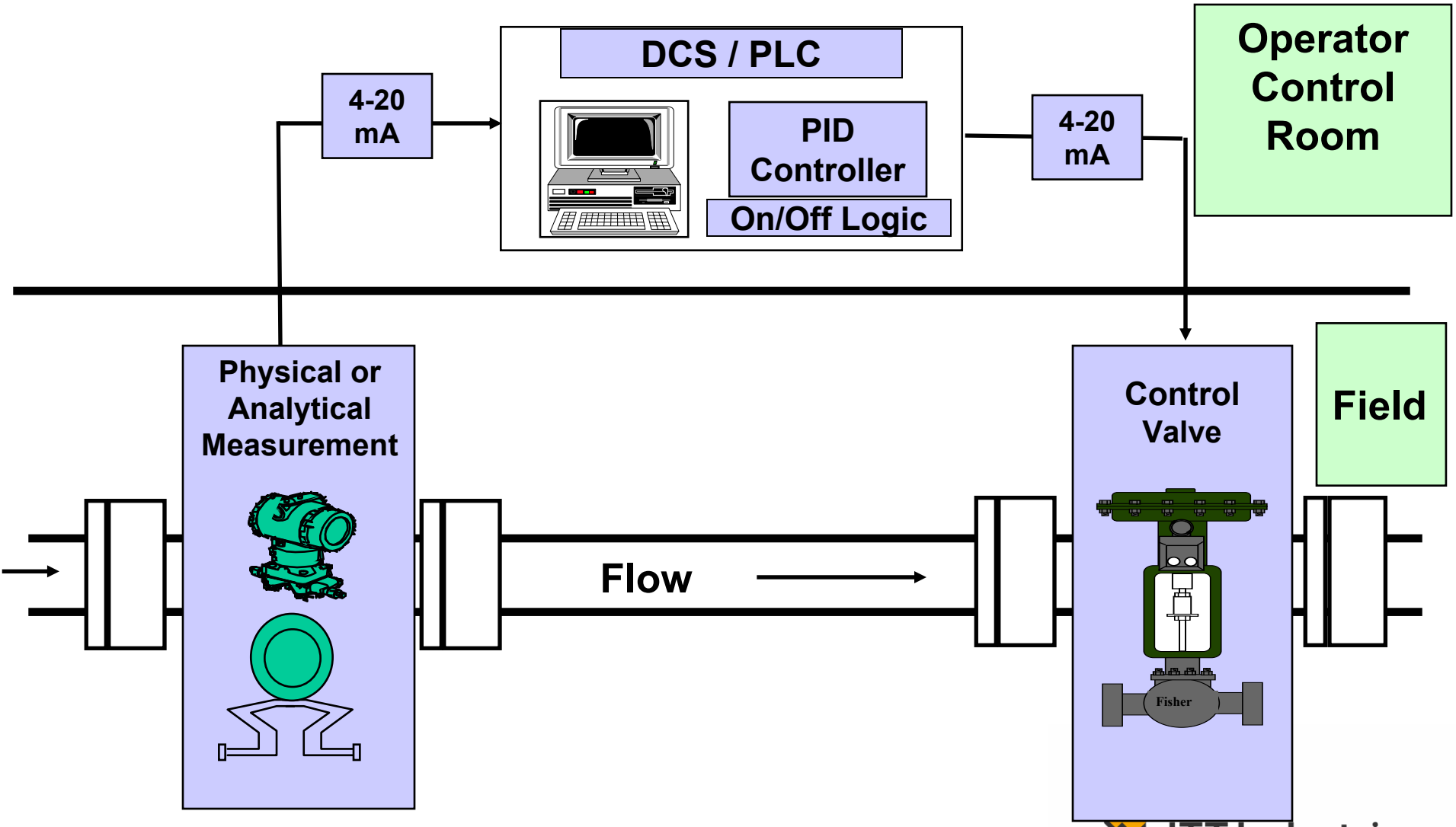
- **Pumps Over-sized for Actual System Demands,**
  Lead to...
  - **Throttling Valves (< 50%)**
  - **Increased Friction Head**
  - **Increased HP Requirement**
  - **Lower MTBF of Seals and Bearings**
    - **Two most common component failures**

- **Opening a Valve 10% can reduce HP consumption > 30%** (at a given load)
  - **Affinity Laws**

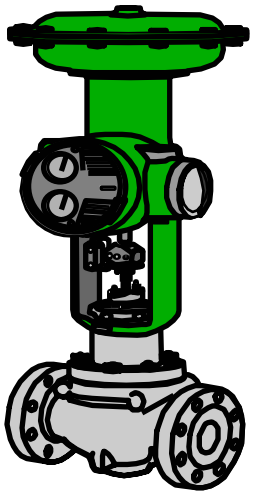
PumpSmart in Process Control

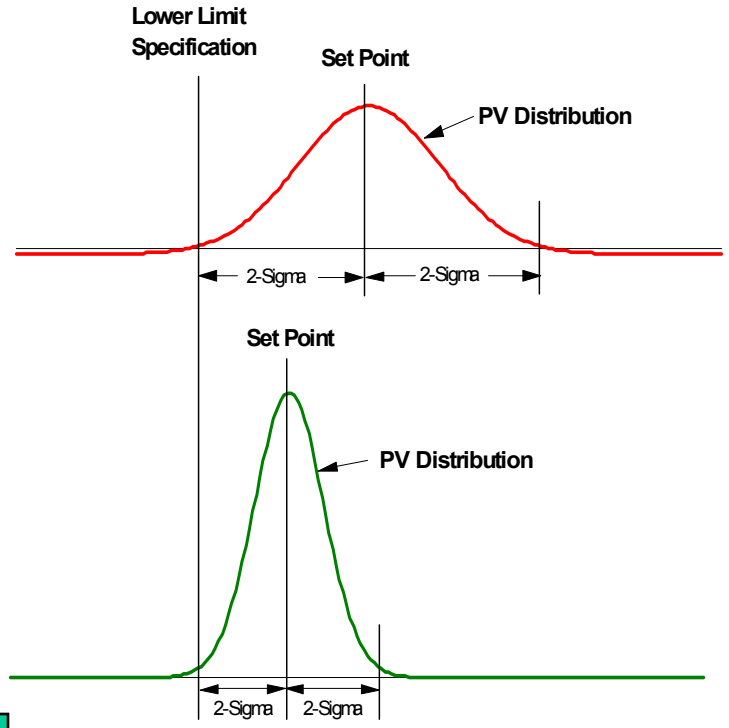
"Changing the Rules of the Game"

The Control Loop -- A Fundamental Building Block



Implementing VFD's as the Primary Control Element





Valve……..……Pump
Actuator……..……..Motor
Positioner……..……VFD

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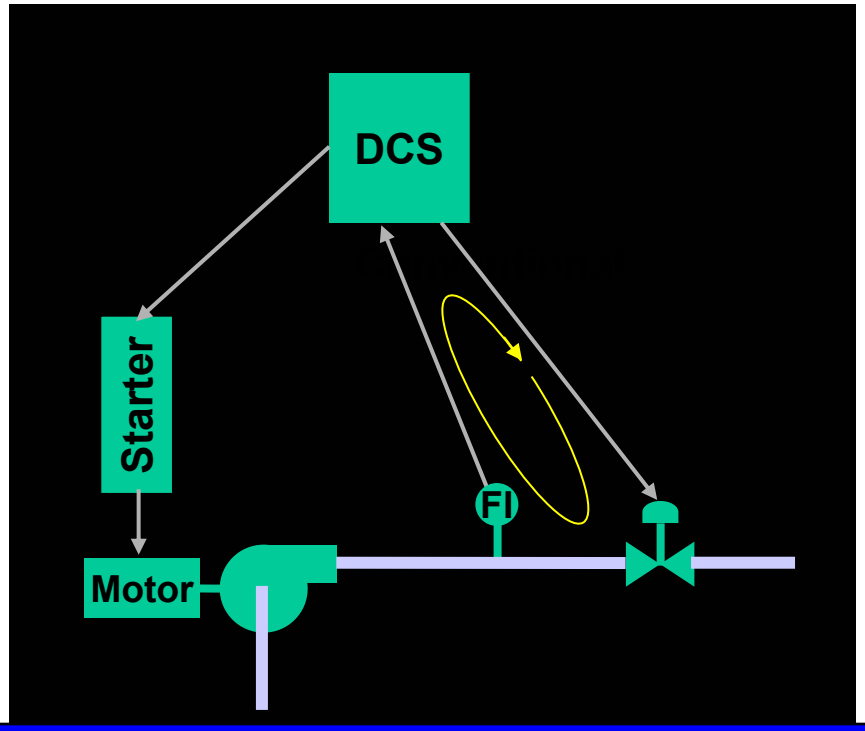
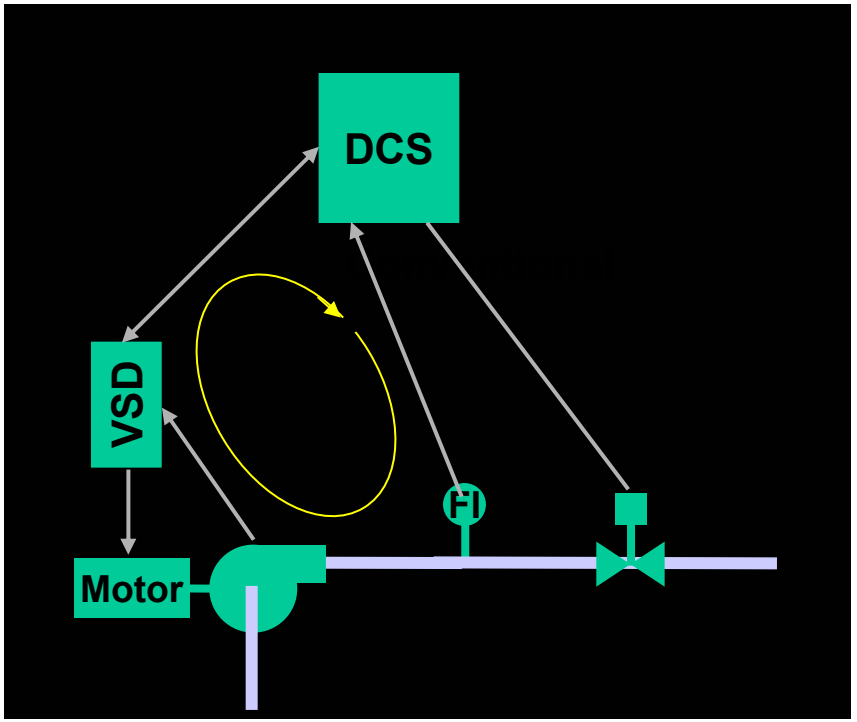
Pumping System Elements

Traditional Pumping System
(Fixed speed pump, control valve, transmitter)

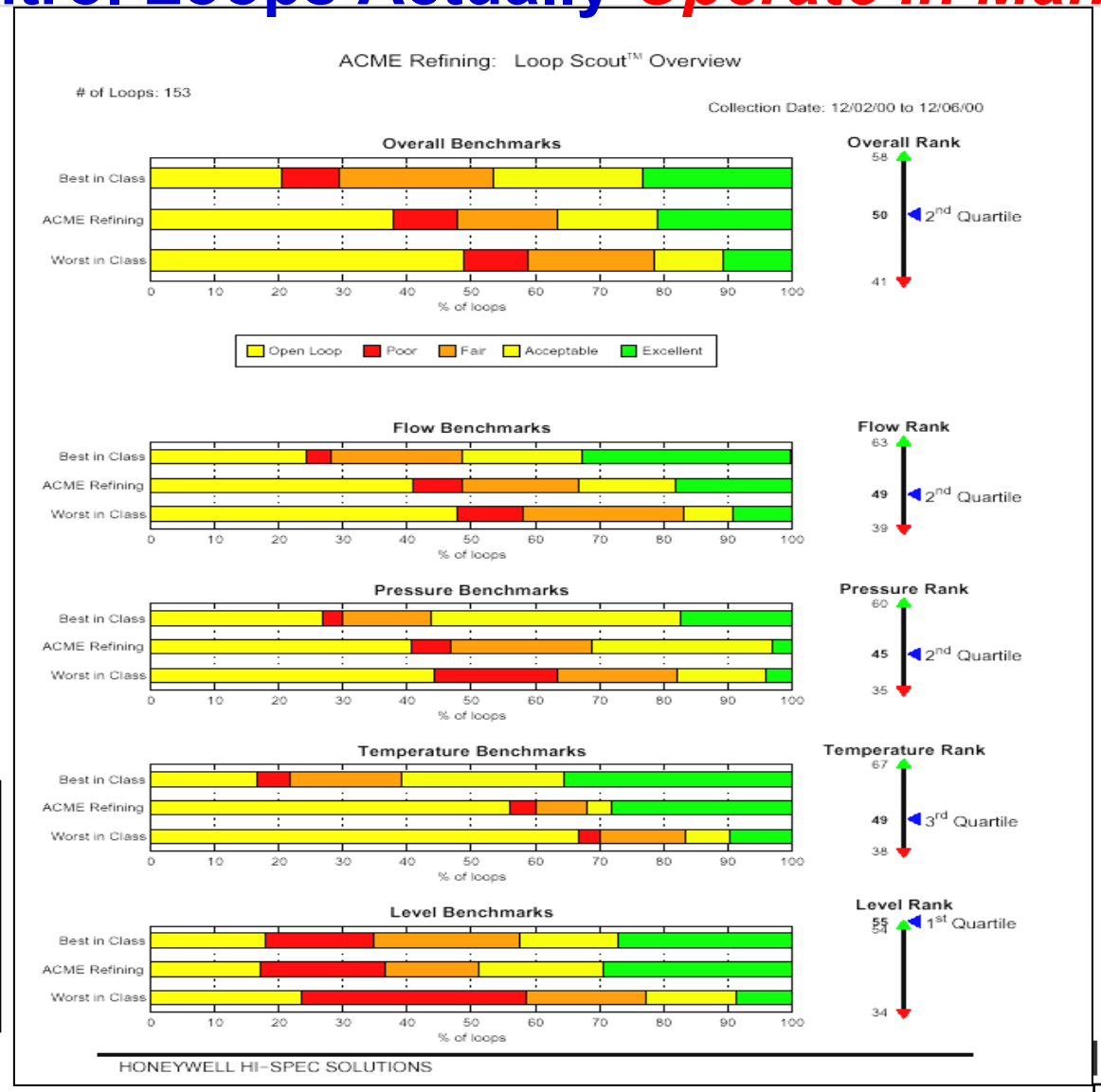


Variable Speed Drive Pumping System



Control loops are tightly associated with pumping systems

Studies Show that as Many as 60% of Control Loops Actually *Operate in Manual*



Source:
@ssetMAX LoopScout --
Results from audits of 300 Plants Worldwide

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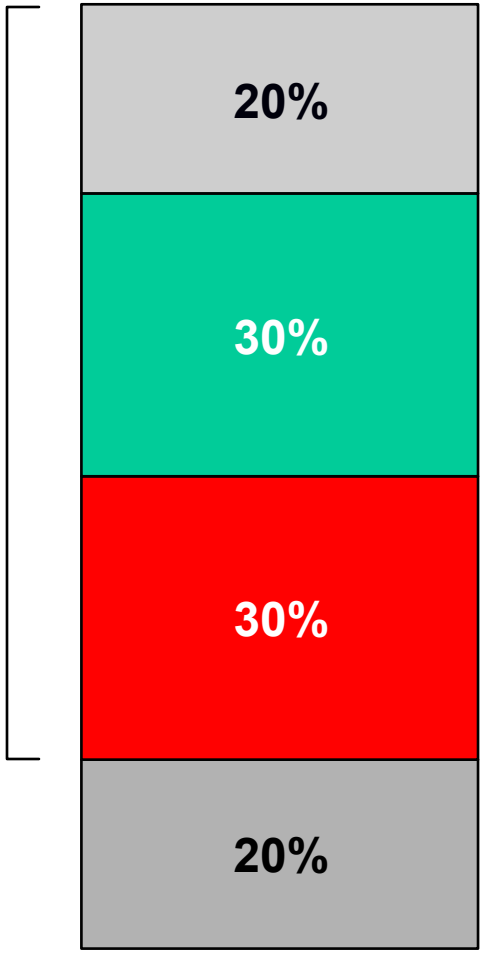
Studies Shows that as Many as 80% of Control Loops Actually *Increase Variability*

Increases Variability



The Reason

- **Design**
- **Tuning**
- **Control Valve Performance**

Source: Entech --- ***Results from audits of over 300 Paper Mills in North America***

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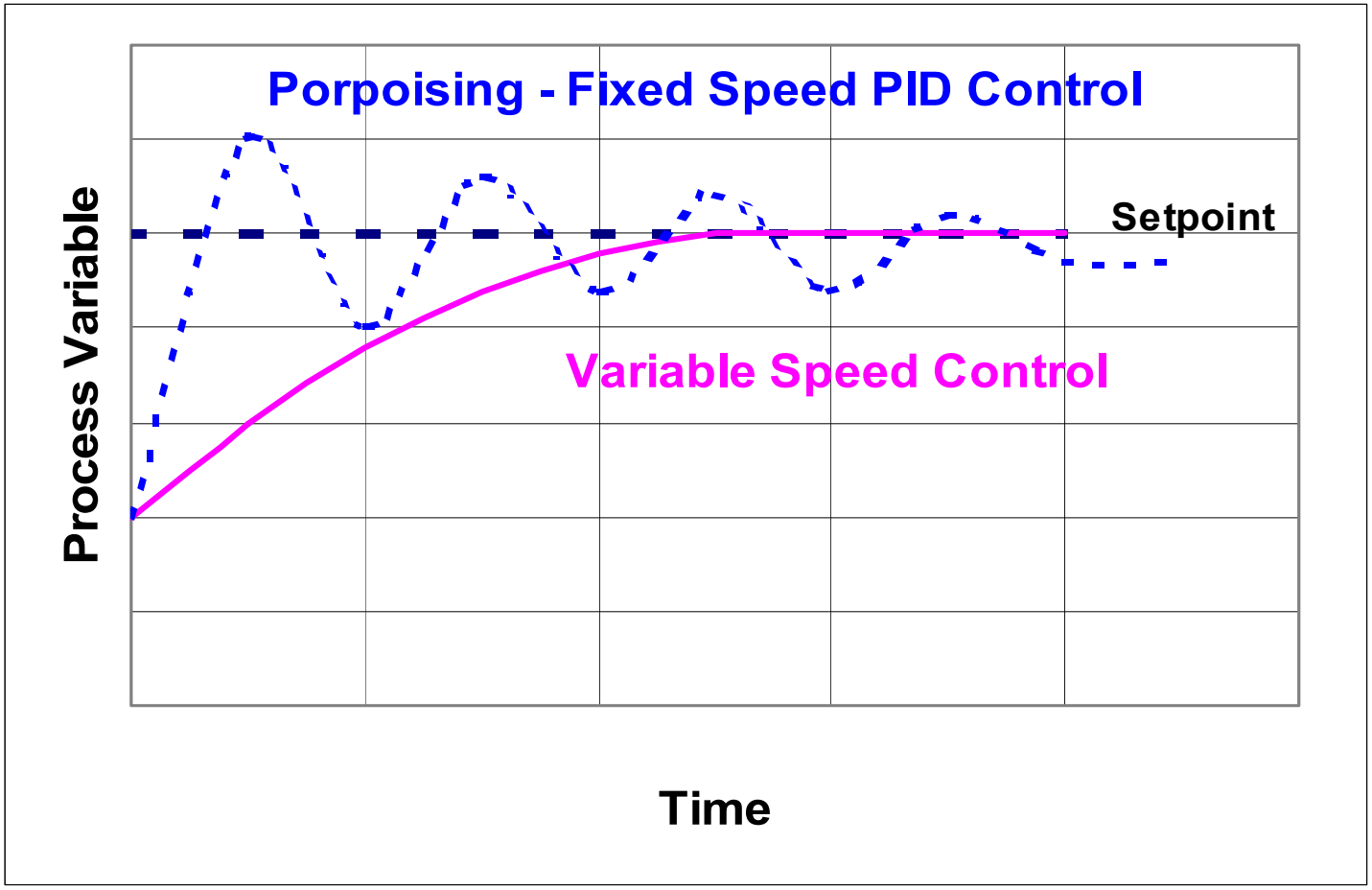
PumpSmart Application
Control Benefits

- **PumpSmart Reduces Process Variability**
  - Control valve backlash and stiction are eliminated. This is the single largest contributor to process variability. The tendency to oversize control valve amplifies the negative impact of backlash and stiction.
  - Overall control performance is improved. The dynamics of the VFD are faster and the process dynamics are more linear. Both of these factors will permit faster tuning with more uniform control performance

PID Loop: Response Time and Porpoising



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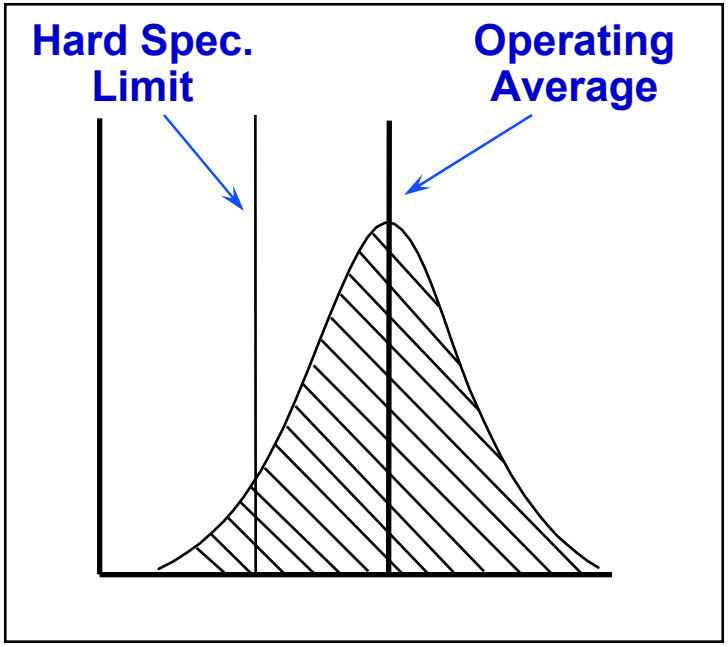
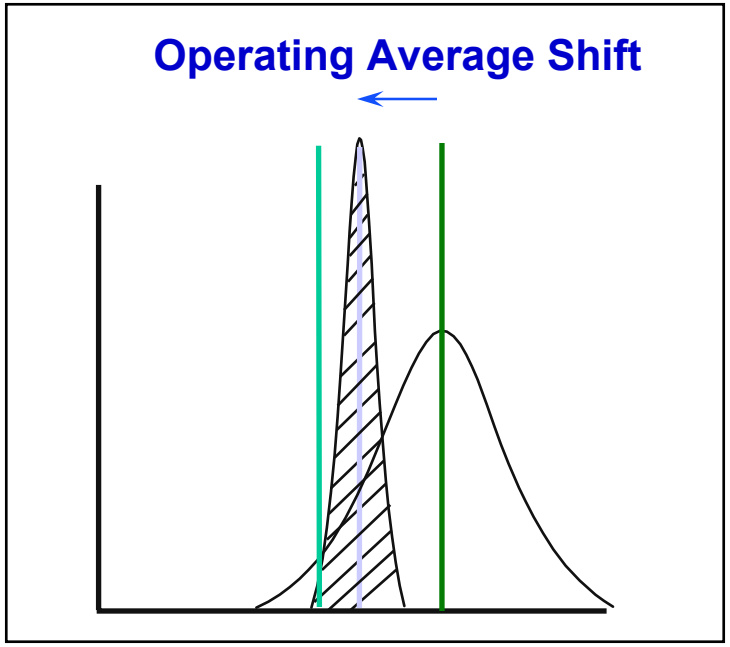
Impact of Improved Measurement and Control on Process Variability





Chemical, Material and Energy Cost ↓

Productivity and Yield ↑

Product Quality ↑

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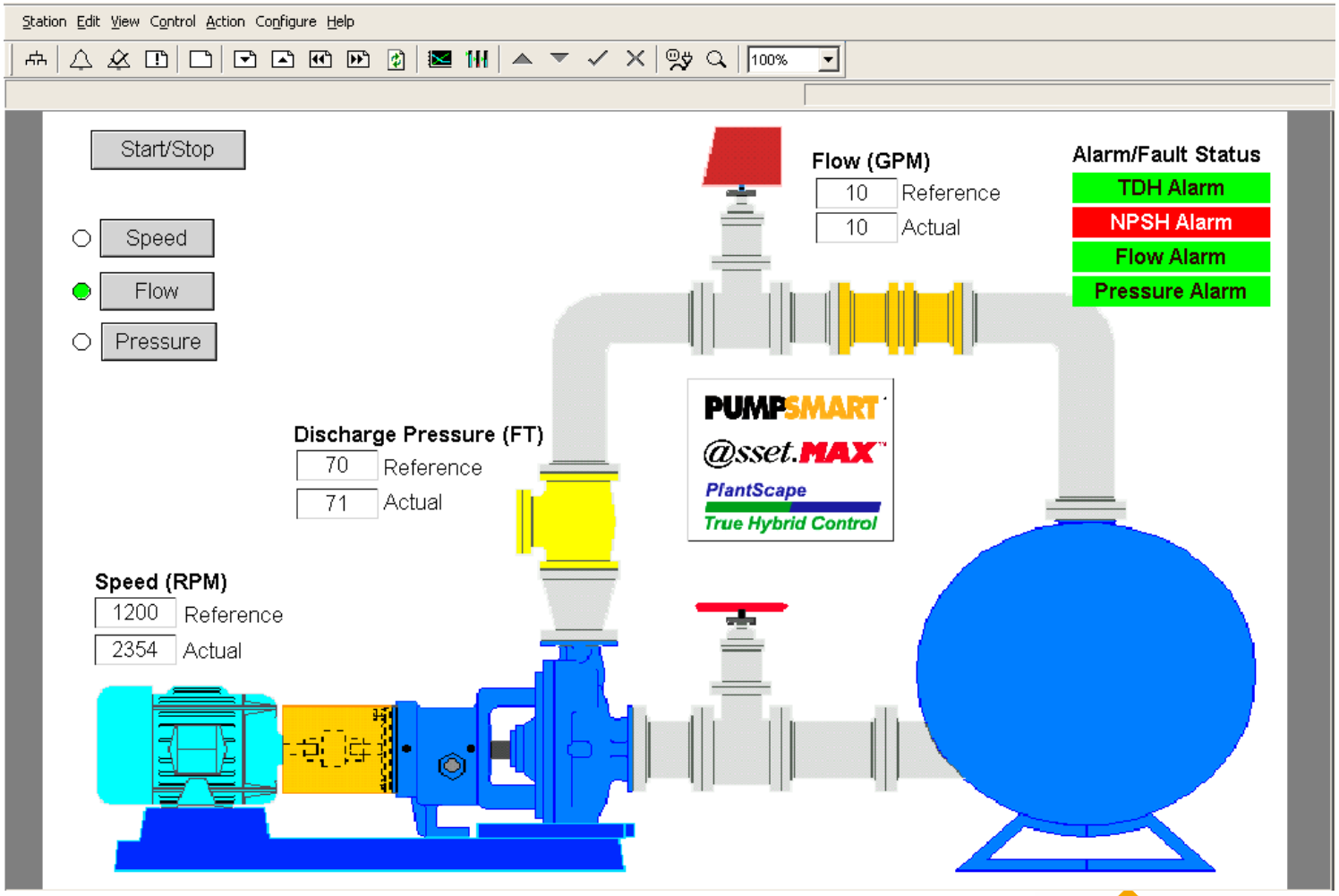
Operating Flexibility and Process Reliability

Improved via PumpSmart Control



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PumpSmart in Asset Management

"Addressing the #1 Business Driver"

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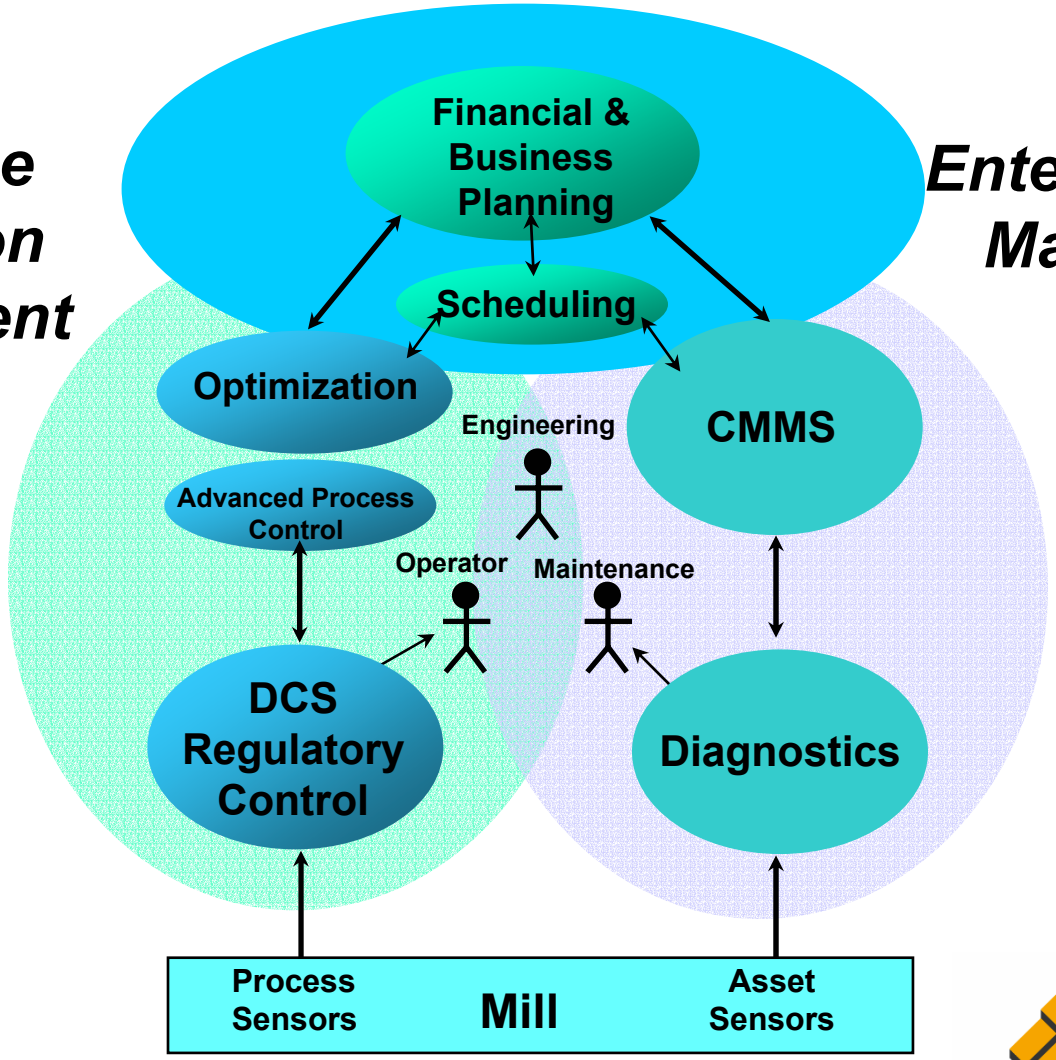
Enterprise Resource Planning (ERP)

Enterprise Production Management (EPM)

Enterprise Asset Management (EAM)



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Enterprise Asset Management Implementations

Automation Research Corp: "Asset Optimization Benefits Not Realized"

- **EAM implementations have left Billions of Dollars of asset optimization benefits on the table**
- **Less than 10% of Enterprise Asset Management (EAM) system users have done more than automate their existing work processes**
- **There are many reasons for the gap between reality and expectations, including the following:**
  - **Most EAM implementations do not provide an integrated view of performance data.**
  - **Condition monitoring data and production data are missing.**

Source: Asset Management (CAM)

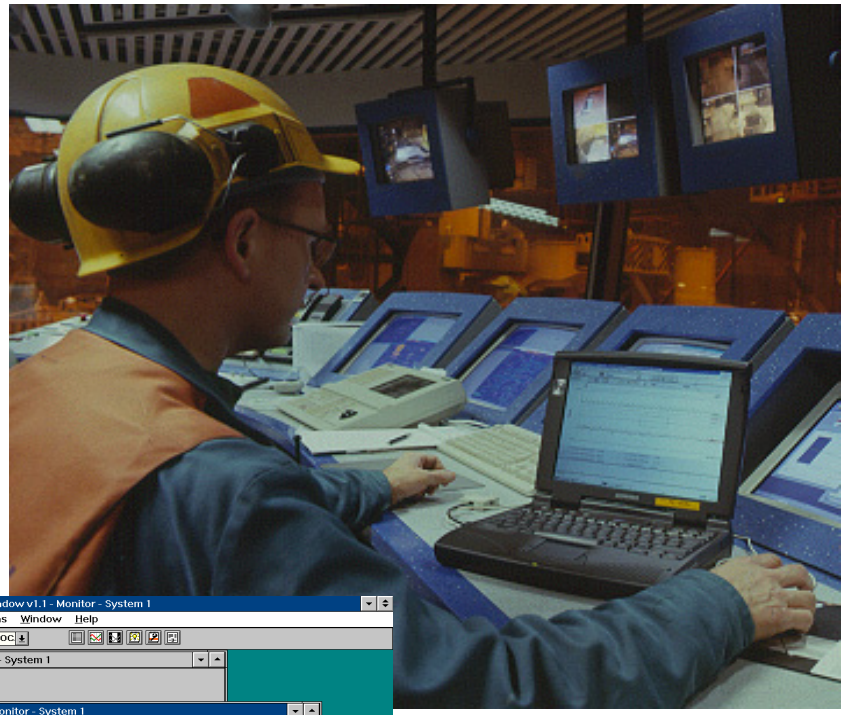
Friday, October 06, 2000

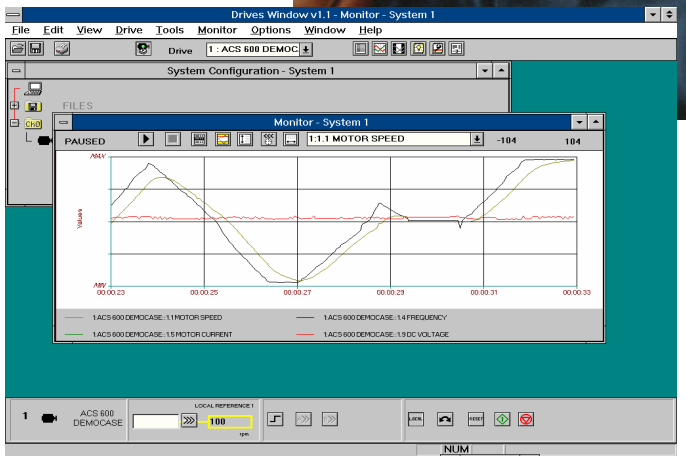
Leif Eriksen

PUMPSMART is an ASSET SENSOR

"Turning Information into Knowledge"

- Up to 84 different parameters monitored
- Display instrument (Flow, Press, Temp) signals
- Monitor hydraulic performance (TDHa)
- Mechanical Fault logger (62 time stamped alarms, e.g., NPSHa)
- Communicates data to DCS, PLC or CMMS





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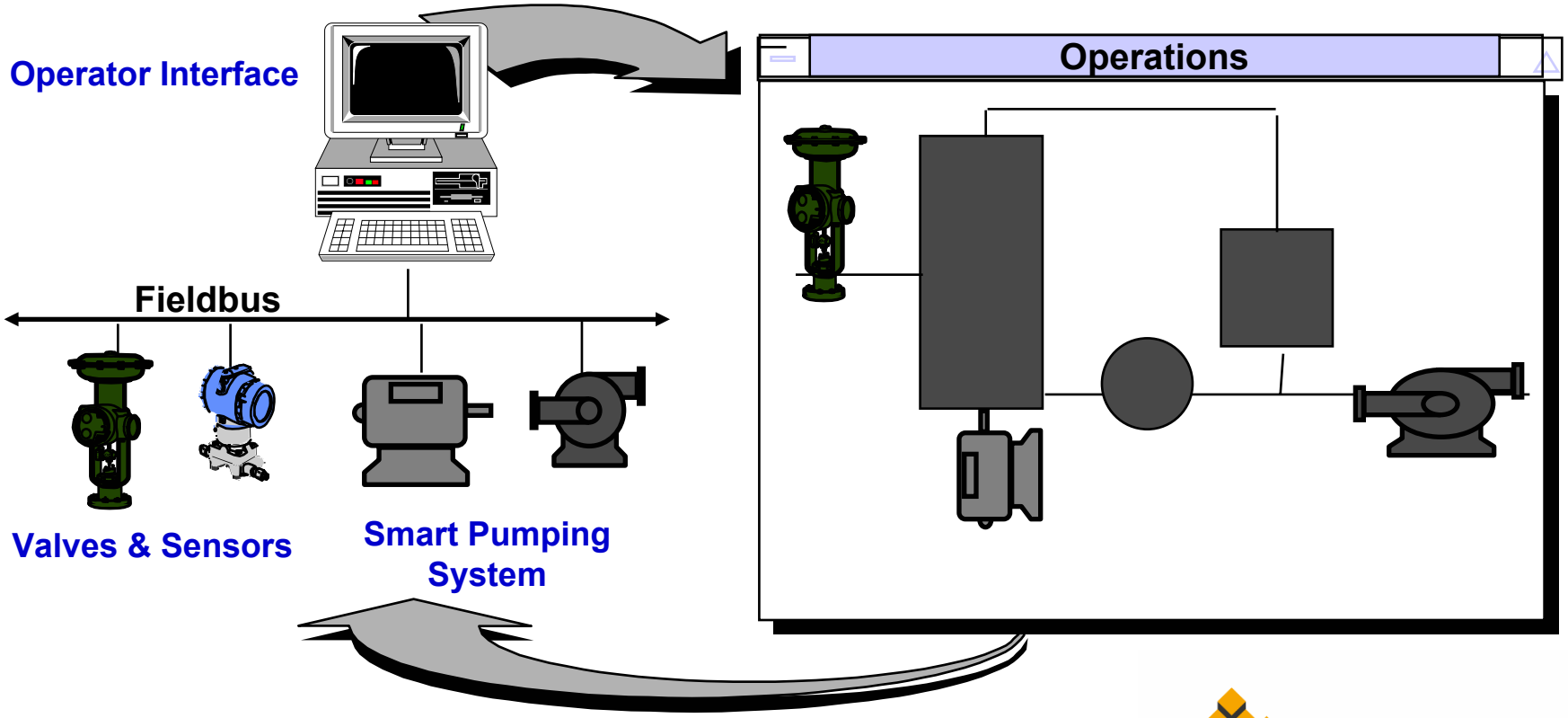
DCS Operator Interface

Pump Condition Monitoring



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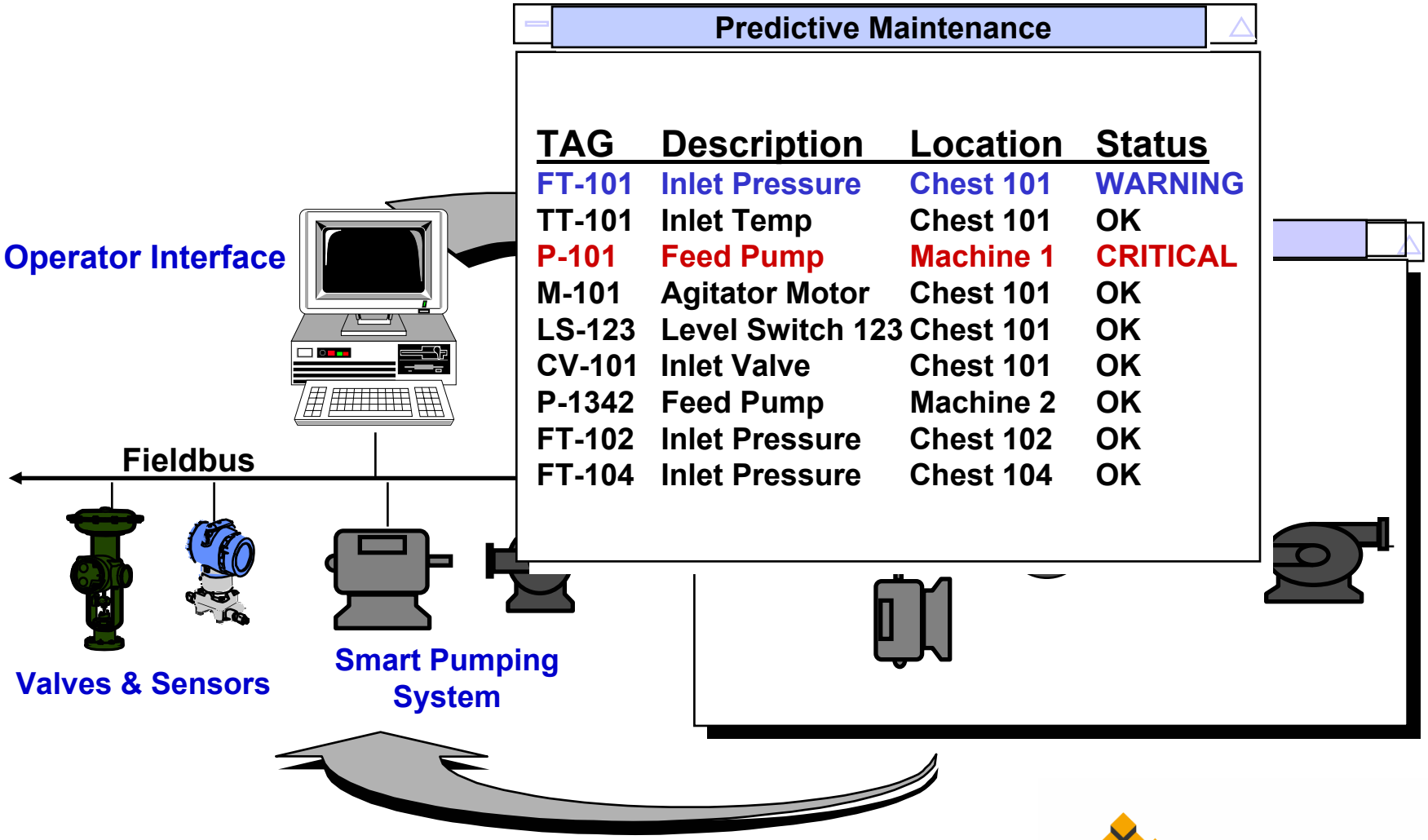
DCS Operator Interface

Pump Condition Monitoring (Cont'd)



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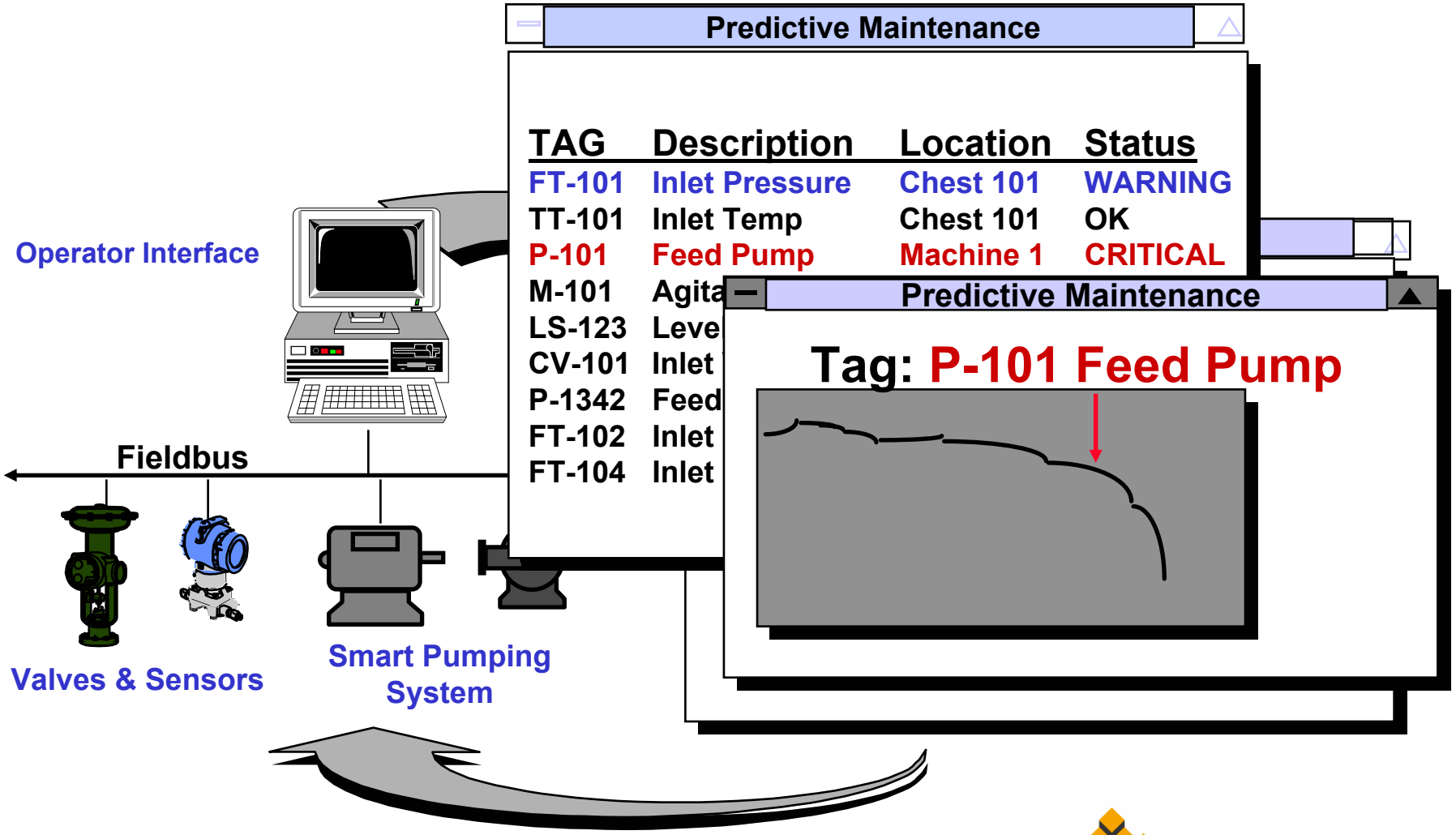
DCS Operator Interface

Pump Condition Monitoring (Cont'd)



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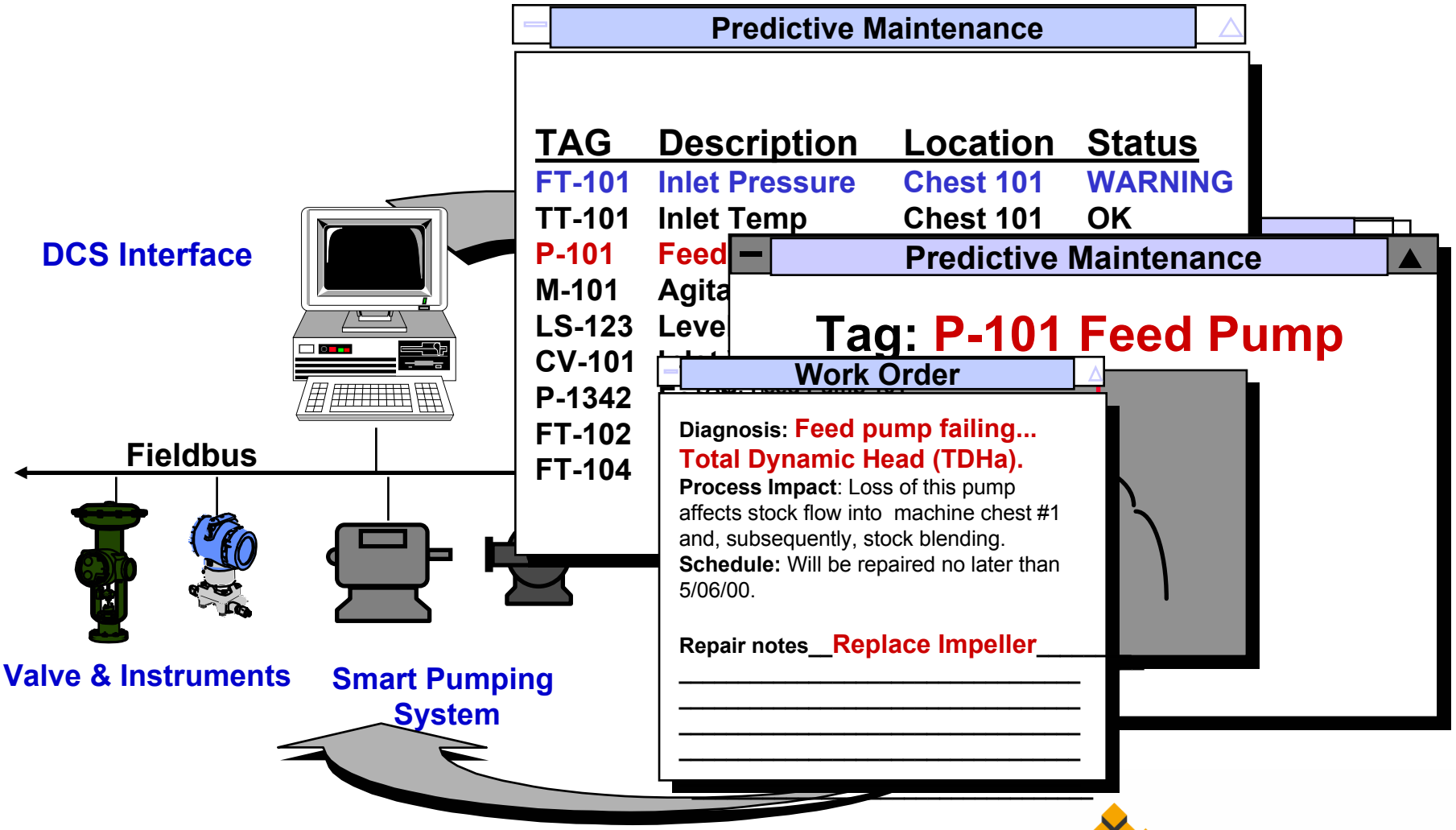
DCS: Operator Interface

Pump Condition Monitoring (Cont'd)



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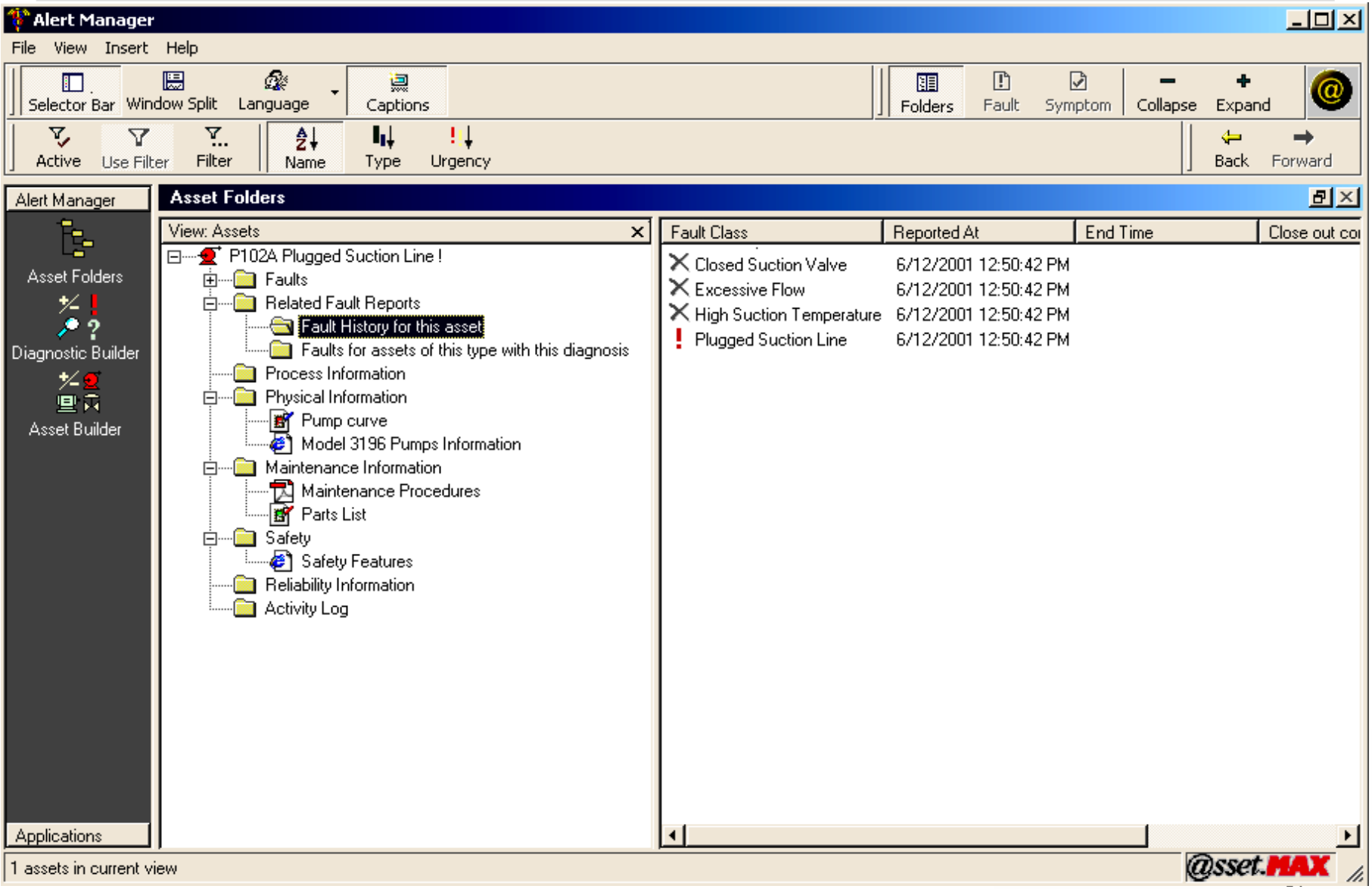
PumpSmart Control Solutions Industrial Pump Group

Asset Management Software

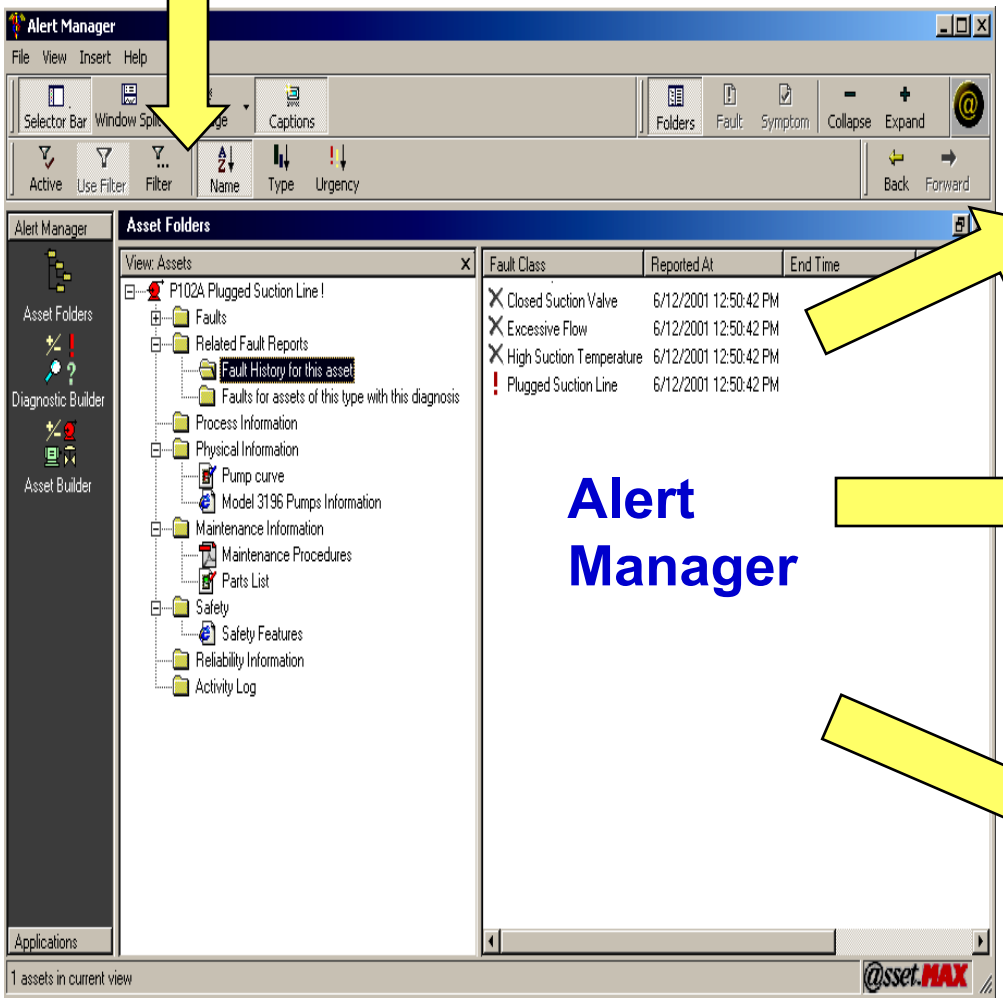
Operator Decision Support



Asset Management Software

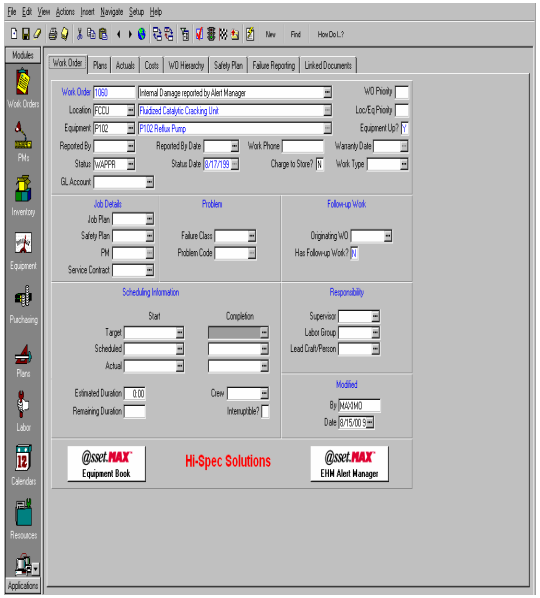
Maintenance and Engineering Support

PUMPSMART®



Paging

Alert Manager



CMMS

Email

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Life Cycle Performance Improvements

Condition Monitoring & Predictive Maintenance

Maintenance Impact

Source: Olin Chemical Corp.

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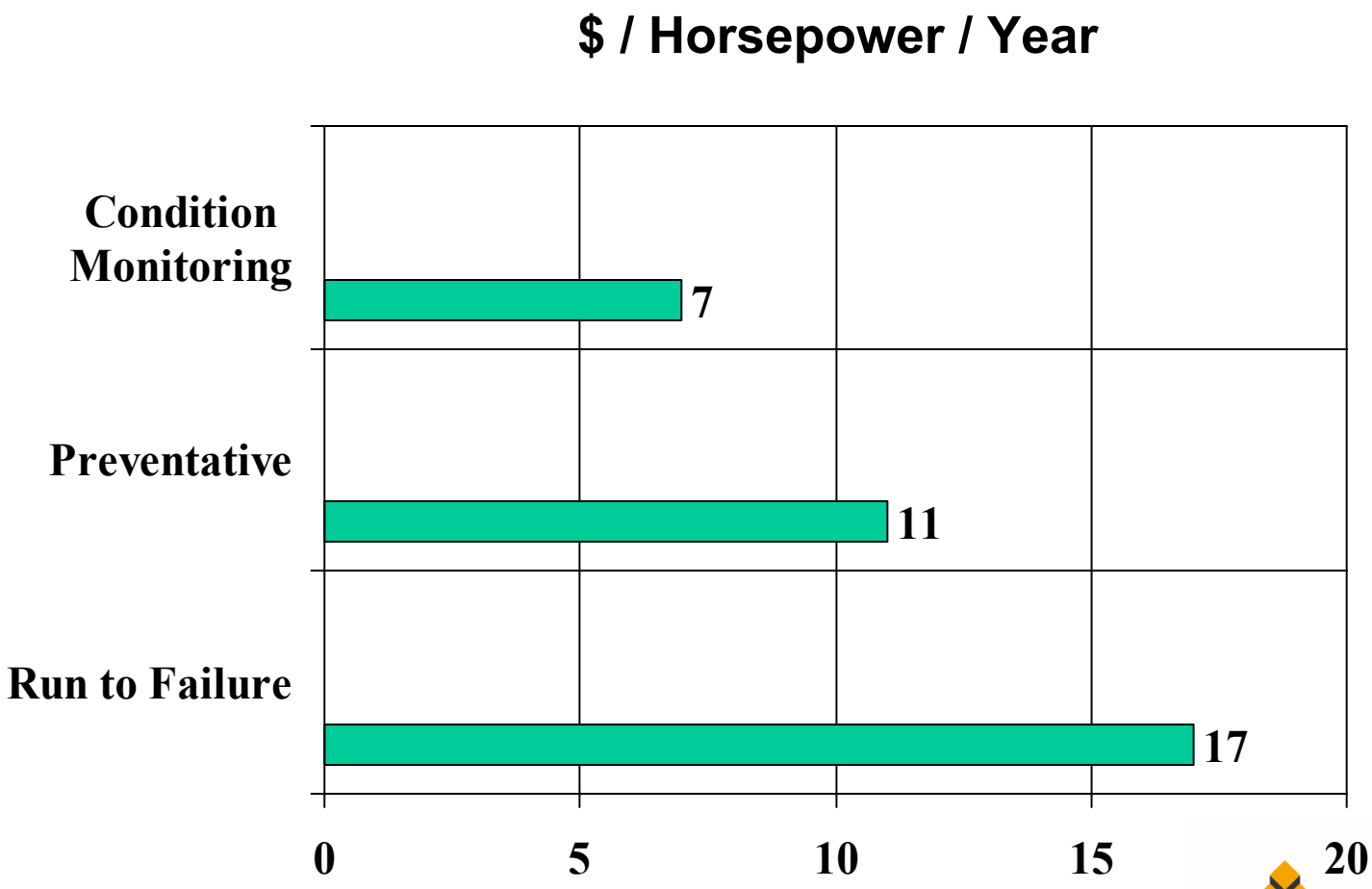
Condition Monitoring Improves...

the Cost of Maintenance in Pulp and Paper



Source: SKF, P&P Maintenance 1994

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Benefits of Condition Based Monitoring

• Maintenance Cost	down 50 - 80%
• Repair Cost	down 50 - 80%
• Spares Inventory	down over 30%
• Overall profitability	up 20 - 60%
• Revenue	up 30%

Source: Data collected from 500 operating CBM systems for over 3 years -- Fadum Enterprises, Inc.

PUMPSMART: Intelligent Machine!

”The question tomorrow will not be whether the machine is smart but what is the IQ of the machine,"

"Smart machinery and processes with embedded sensors and controls allow for better modeling, for faster, smoother transitions such as start-ups and production changes, tighter control during continuous operation, and faster diagnostics of potential machine problems before product quality or process operation is negatively affected."

- PIMA's North American Papermaker, March 2000

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